



Vishay Load Dump TVS Series for 24 V Powertrains

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As more trucks and buses are built with complex electrical systems, load dump protection is becoming an important safety feature for vehicles with 24 V powertrains. This article describes the changes to the load dump test condition and defines the maximum surge suppressing capability for Vishay load dump TVS series in these conditions.

THE NEW ISO STANDARD ISO-16750-2 (2010) VS. THE OLD ISO STANDARD ISO-7637-2 (2004)

The most significant difference between the new and old load dump tests is that the new standard (ISO-16750-2, 2010) requires 10 pulses in 10 minutes with a one-minute interval per pulse, as shown in Table 1. The old standard (ISO-7637-2, 2004) required only a single pulse.

TABLE 1: PULSE REQUIREMENTS FOR ISO-16750-2

PARAMETER	TYPE OF SYSTEM		MINIMUM TEST REQUIREMENTS
	$U_A = 12\text{ V}$	$U_A = 24\text{ V}$	
U_S (V)	79 to 101	151 to 202	10 pulses at intervals of 1 min
R_i (Ω)	0.5 to 4	1 to 8	
t_d (ms)	40 to 400	100 to 350	
t_r (ms)	10 / +0 / -5	10 / +0 / -5	

The test condition of the 10 pulses in 10 minutes shows the reliability of the load dump protection device, which assists the circuit designer in selecting the best device based on surge capability in high temperature conditions.

LOAD DUMP PROTECTION FOR 24 V SYSTEMS USING AN AEC-Q101 QUALIFIED TVS SERIES DEVICE

Fig.1 illustrates the load dump protection device clamping in the specified voltage range, which is different from the standard waveform. The active voltage range of the clamping device in the load dump pulse is the reason for this difference, as shown in Fig.1. The device in Fig. 2 is clamping at 202 V U_S , 3.5 Ω R_i , and a 350 ms pulse width.

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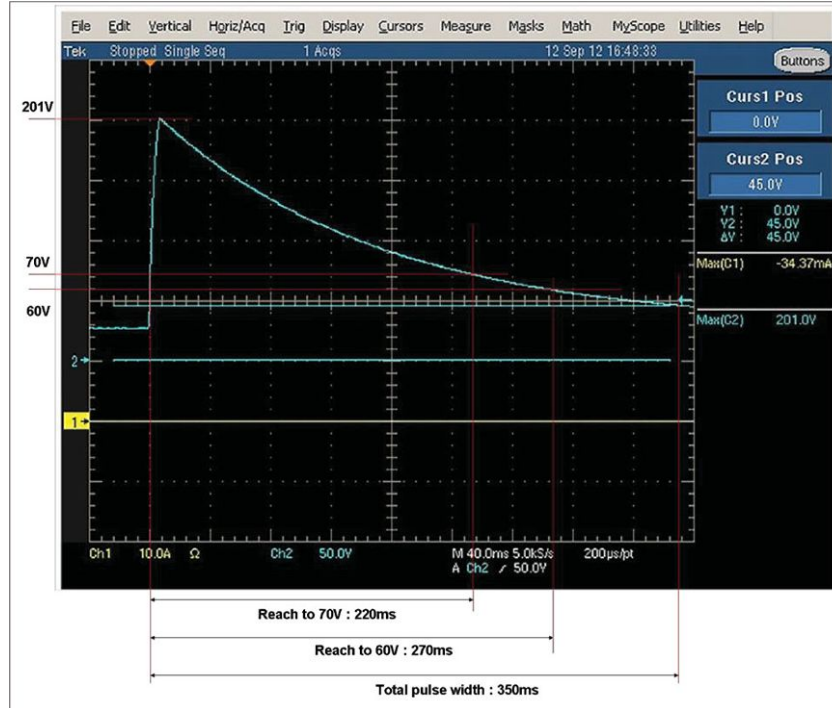


Fig. 1 - Input Waveform of an ISO-16750-2 Pulse: 5 A, 201 V U_S , 350 ms Pulse Width Condition

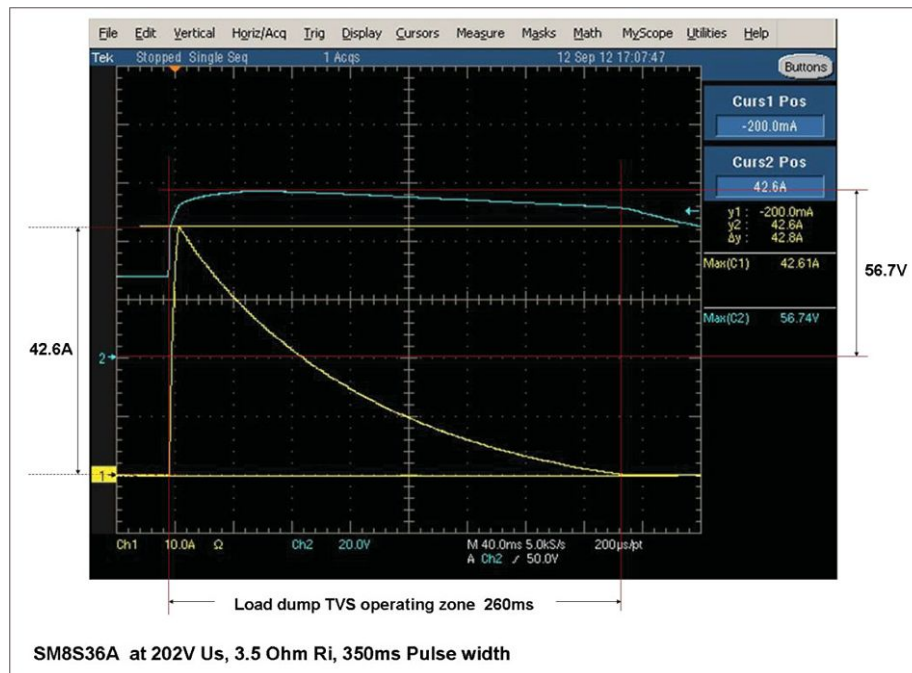


Fig. 2 - Clamped Waveform of the SM8S36A at an ISO-16750-2 Pulse: 5 A, 202 V U_S , 3.5 Ω R_i , 350 ms Pulse Input Condition

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PROTECTING ELECTRONIC DEVICES IN LOAD DUMP STATUS BY USING A TVS DEVICE

The function of a load dump protection device is to keep the clamping voltage under the maximum input voltage of the power regulator, or other electronic components in the circuit, without halting or powering down the system. The protection device will not operate until the line voltage reaches 36 V for 1 to 10 minutes or longer, as specified by the vehicle's manufacturer or as required in withstand test conditions. This means the device does not perform at 36 V in any kind of status in either high or low temperature environments.

The clamping voltage of the load dump TVS device rises as the junction temperature changes during continuous clamping operation. Fig. 3 shows that the operating time of the load dump TVS device is increased when R_i is increased, with an operating time of 300 ms, which is longer than the 3.5 Ω R_i condition shown in Fig. 2.

SM8S36A at $U_S = 202$ V, $R_i = 4$ Ω , $t_d = 350$ ms

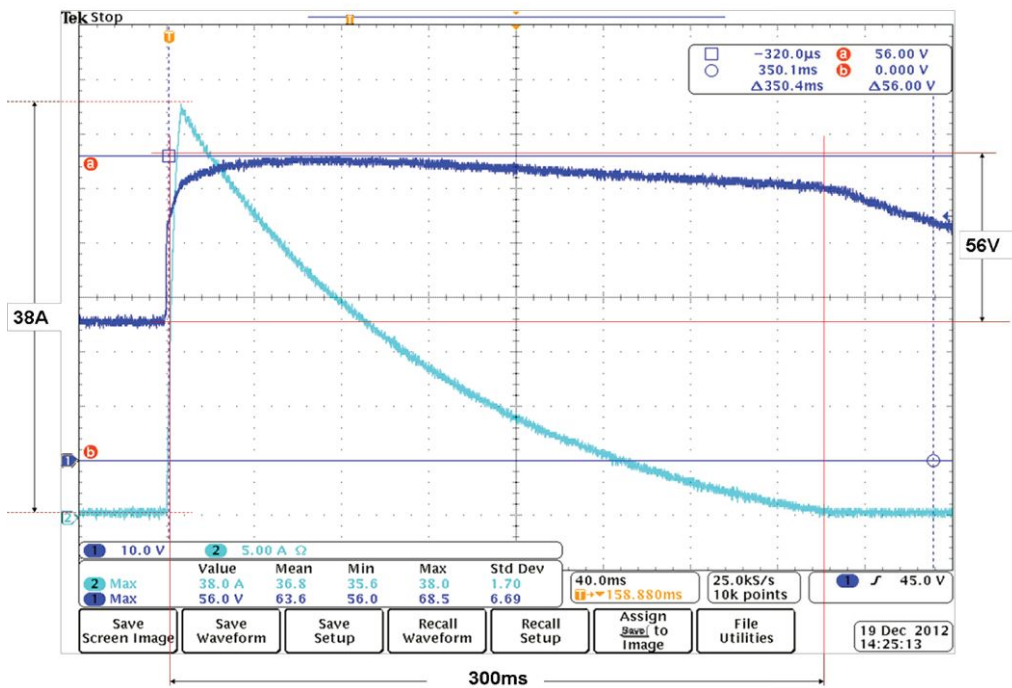


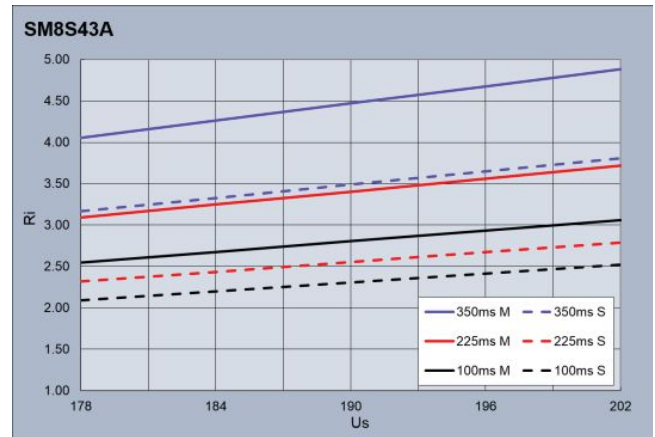
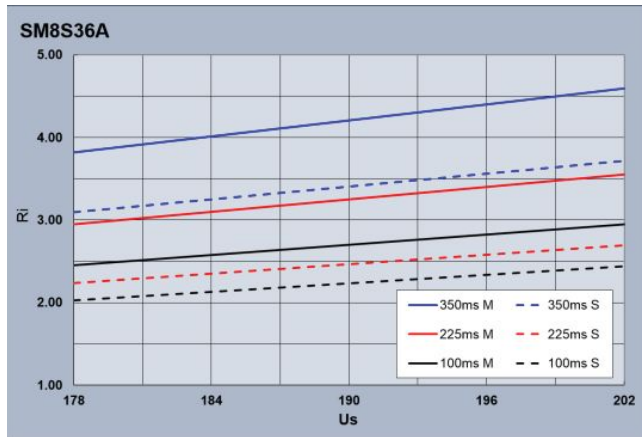
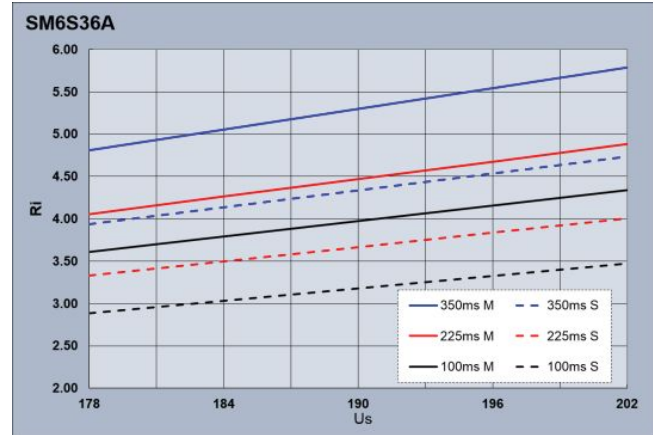
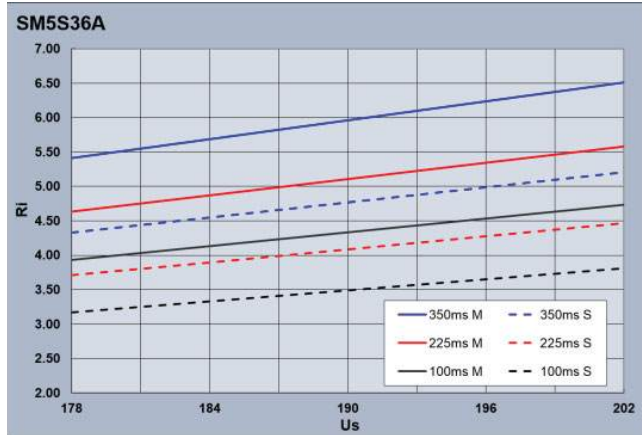
Fig. 3 - SM8S36A at $U_S = 202$ V, $R_i = 4.0$ Ω , 350 ms Pulse Width



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CAPABILITY OF VISHAY'S LOAD DUMP TVS SERIES USING THE NEW LOAD DUMP TEST CONDITION STANDARD

The following graphs show how using the new test condition of 10 continuous pulses affected the surge suppressing capability of the load dump TVS device.



Graphs 1 to 4: Capabilities of Vishay's SM5S series in the new load dump test conditions. Suffix "M" lines are multiple pulses using the new test condition standards (ISO16750-2); suffix "S" lines are a single pulse as defined by the old test condition standards (ISO7637-2). Please note that these values are based on a normal room temperature environment on a pad size, as recommended in the datasheet. Actual capability varies depending on PCB type, pad size, and temperature conditions. Clamping capability relating to junction temperature and derating ratio are similar to "Load Dump Power Characteristics" in the datasheet.

The following graphs illustrate a solution for low R_i by using two or three devices in a series.

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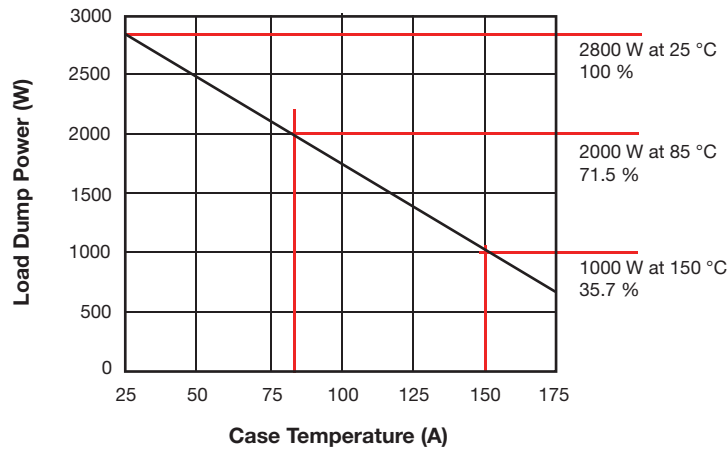
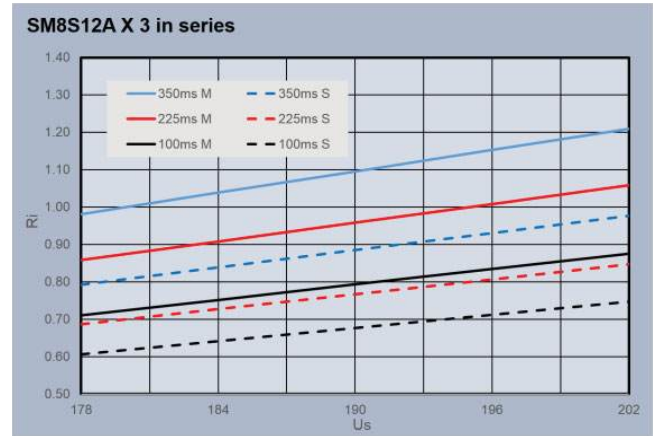
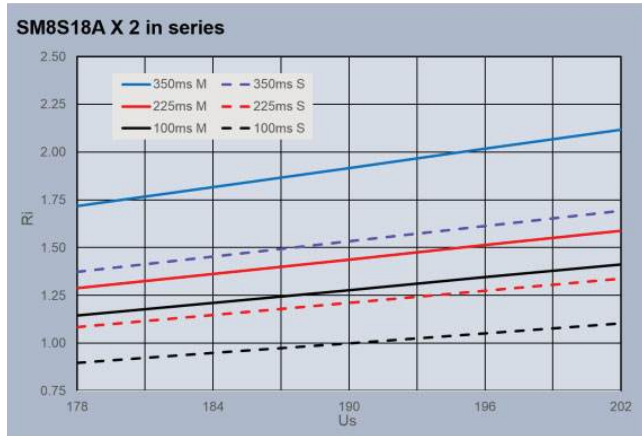


Fig. 4 - Derating Ratio of the Load Dump Power Characteristics at Case Temperature for the SM5S Series

APPENDIX

EASY REFERENCE FOR LOAD DUMP TVS vs. PEAK CURRENT (A)						
TOTAL PULSE WIDTH	SINGLE PULSE			10 PULSES IN 10 MINUTES		
	100 ms	225 ms	350 ms	100 ms	225 ms	350 ms
SM5S36A	37	30	24	28	24	21
SM5S36A	39	33	27	31	27	23
SM5S36A	56	51	37	46	38	29
SM5S43A	54	49	35	45	37	28
SM8S18A X 2	125	105	83	100	88	67
SM8S12A x 3	190	165	145	160	130	115

For a more detailed explanation of load dump protection, please refer to the article: "Load Dump Protection: Old vs. New ISO Standards" (www.vishay.com/doc?49748).